EXHIBIT 10

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The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy

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Using the logit model, and assuming Nash equilibrium in prices and constant marginal cost, it is straightforward to estimate critical demand parameters and simulate mergers. In this way, the logit model can be used to predict the price and welfare effects of mergers. We explore the effects of mergers in this model both analytically and through simulations of hypothetical mergers of U.S. long distance carriers. We find that only mergers involving AT&T would be likely to lessen welfare significantly. Simulations such as these provide a firmer foundation for antitrust policy than traditional structural indicators. The logit model is not always appropriate, but the basic methodology can be adapted to other demand systems.

1. Introduction

The price and welfare effects of mergers in Cournot models with homogeneous products have been the subject of several analyses in recent years (for example, Farrell and Shapiro, 1990; McAfee and Williams, 1992; Werden, 1991). However, Bertrand models with differentiated products may be of greater relevance to antitrust policy. Few industries have a truly homogeneous product and only one price, and despite the insights of Kreps and Scheinkman (1983), there remain doubts about the quantity-setting assumption. In addition, the assumption of a noncooperative competitive interaction is more likely to be reasonable with differentiated products than with homogeneous products.[1]

The most notable studies on Bertrand mergers are those by Levy and Reitzes (1992) and Deneckere and Davidson (1985). Levy and Reitzes consid-

1. We believe that the competitive interaction is likely to be noncooperative in most differentiated product industries, in part because product differentiation tends to make it more difficult to reach collusive agreements (unless it is straightforward to allocate customers or the like). We recognize, however, that some sort of collusion is widely thought to have occurred in some differentiated products industries, notably breakfast cereals and cigarettes.

er a model of localized, spatial competition, with each firm competing direct-ly with only the adjoining firms around a circle. Deneckere and Davidson consider a model of generalized competition with linear demand. Neither study provides useful guidance for merger policy by indicating how the price and welfare effects of mergers relate to market shares, demand elasticities, and other factors that can be assessed in an antitrust case.[2] This is partially due to the fact that both consider only the symmetric case, even though differentiated products industries are often highly asymmetric. Moreover, Levy and Reitzes consider strictly localized competition in a single dimen-sion, which certainly is not typical.

We examine the price and welfare effects of Bertrand mergers in the context of a more appealing model of generalized competition—the logit model. Although the logit model has substantial limitations, it is of significant interest for several reasons. First, the logit model is simple enough to permit the derivation of analytic results, which significantly extend the work of Levy and Reitzes and Deneckere and Davidson. Second, the logit model has direct policy relevance, since the 1992 Horizontal Merger Guidelines use it as the base case for the analysis of mergers in differentiated products industries. The logit model is a base case in the sense that the merging firms are neither especially close in product space nor especially far apart.[3] Finally, the logit model is very practical for use in antitrust cases with limited data and severe time pressure.[4] The only inputs required for simulating mergers in our version of the logit model are market shares and prices, which can be easily observed, and two demand elasticity parameters, which can be fairly easily estimated using well established methods, or guessed at in a pinch.

Among the implications of this model are: The prices of all products in the industry increase as a result of a merger, but the magnitudes of the price increases are very different for different products. If the merging firms are of different size, their merger has asymmetric effects on their prices; the price of the smaller-share product is increased much more than that of the larger-share product. In addition, the merged firm typically increases the weighted average of its two prices much more than any nonmerging firm increases its price. Larger nonmerging firms increase price more than smaller ones, so increased concentration among the nonmerging firms increases the price effect of a merger, but the effect is typically fairly weak. Finally, mergers may enhance welfare even though they increase price, and increased concentration among the nonmerging firms may reduce the welfare loss from a merger, or even reverse it.

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2. Deneckere and Davidson do offer a fairly general proof that prices increase as a result of Bertrand mergers in differentiated products industries. In another recent study, McElroy (1993) shows that it is possible for some prices to fall as a result of a Bertrand merger.

3. See U.S. Department of Justice and Federal Trade Commission (1922: § 2.21) and com-pare with Willig (1991: 299–304).

4. The law requires that the government be given just 30 days advance notice of mergers, and it may be infeasible to undo a merger after it is consummated.

To illustrate the application of the model, we analyze the price and welfare effects of mergers among existing U.S. long-distance carriers. We make two alternative assumptions concerning the effects of mergers on costs. One assumption is that mergers have no effect on costs, and this is probably the most reasonable assumption. Under this assumption, mergers involving AT&T have significant adverse welfare effects, and mergers not involving AT&T have much smaller welfare effects. The alternative cost assumption is that a merged firm has a marginal cost equal to the lesser of the two marginal costs of the merging firms. Under this assumption, all mergers of pairs of long-distance carriers enhance total welfare, except that of AT&T with MCI.

Section 2 presents our version of the logit model; Section 3 considers the effects of mergers in logit oligopoly on price and welfare; and Section 4 briefly examines the comparative static effects of changing the two demand elasticity parameters. Section 5 illustrates the application of the logit model to hypothetical mergers among U.S. long-distance carriers. Section 6 considers the limitations of the logit model and discusses alternatives. Section 7 offers a few observations on the Merger Guidelines' specific enforcement standards for differentiated products industries. Finally, Section 8 offers some concluding remarks.

2. Logit Oligopoly

A logit demand system generally is motivated by a random utility model in which consumers make a discrete choice among a set, C, of n alternatives, selecting the alternative yielding the greatest utility (see Ben-Akiva and Lerman, 1985: 55–57, 100–104; McFadden, 1974: 106–10). We consider a version of the model that specifies the indirect utility of consumer i associated with the choice of product j as

$$U_{ij} = \alpha_j - \beta p_j + e_{ij}. \tag{1}$$

The price coefficient, β, is assumed to be constant for all consumers and products,[5] and all generally perceived quality differences among products are summarized by the α_j's. The disturbance term, e_{ij}, represents an individual-specific component of utility that is uncorrelated with price, p_j. If the e_{ij}'s are independently and identically distributed according to the extreme value distribution, the choice probabilities have the familiar logistic form (see Ben-Akiva and Lerman, 1985: 104–6; McFadden, 1974: 110–12):

$$\pi_j = \exp(\alpha j - \beta p_j) / \sum_{k \in C} \exp(\alpha_k - \beta p_k). \tag{2}$$

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5. This formulation is appropriate only if price is appropriately normalized. For example, if different-size packages of detergent are alternative choices, price must be per unit of volume or weight, rather than per package.

For our purposes, it is more convenient to express the model in traditional antitrust terms. We define product n to reflect the choice of "none of the above" (i.e., to be the outside good) and we assume $p_n \equiv 0$ to make the utility of the outside good a constant. The vector of the remaining prices is denoted **p**, and the share-weighted average premerger price for the inside goods is denoted $\bar{p}$. We term as "shares," denoted **s**, the vector of choice probabilities for the "inside goods" (i.e., those other than the outside good), conditional on the choice being an inside good.

The (positive) own-price and cross-price elasticities of demand for particular inside goods, ε_j and ε_{jk}, are

$$\varepsilon_j = \beta p_j (1 - \pi_j) = [\beta \bar{p}(1 - s_j) + \varepsilon s_j] p_j / \bar{p} \tag{3}$$

$$\varepsilon_{jk} = \beta p_k \pi_k = s_k (\beta \bar{p} - \varepsilon) p_k / \bar{p}. \tag{4}$$

There is also an implied (positive) "aggregate elasticity of demand for the inside goods," specifically

$$\varepsilon \equiv -[\partial \pi_i(\lambda \mathbf{p}) / \partial \lambda][\bar{p} / \pi_i(\mathbf{p})] = \beta \bar{p} \pi_n, \tag{5}$$

where $\pi_i(\mathbf{p}) \equiv 1 - \pi_n(\mathbf{p})$ is the sum of the choice probabilities for the inside goods, λ is a scalar, and the derivative is evaluated at $\lambda = 1$.

The primitives of our version of the model, which completely characterize an industry, are shares, **s**, and prices, **p**, both of which can be observed, and the parameters ε and β, both of which can be estimated. Roughly speaking, β is the cross elasticity of demand parameter, controlling the substitutabilities among the inside goods; and ε is the aggregate elasticity of demand parameter, controlling the substitutability between the inside goods and the outside good.

There are several reasons for making ε rather than π_n a primitive of the model. First, economists are accustomed to dealing with demand elasticities, so the underpinnings of a merger simulation will be better understood if an assumption is made with respect to ε rather than π_n. Second, discrete choice models are not designed to estimate the implied aggregate demand elasticity. It is, therefore, preferable to estimate that elasticity using aggregate data and the corresponding econometric tools. We link the aggregate demand estimation with the discrete choice estimation by choosing the value for π_n that is consistent with the aggregate estimate of ε. In our model, π_n is not really a probability at all, but rather a scaling factor used to achieve this consistency.[6]

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6. The conventional approach has been to let π_n be the actual probability of choosing none of the above and to place the remaining products in a nest to make the inside goods better substitutes for each other than the outside good is for them. This approach links in an undesirable way the aggregate elasticity of demand with the cross elasticities of demand within the nest. A change in the nesting parameter that makes products in the nest better substitutes for each other necessarily makes outside goods less good substitutes for the products in the nest.

Differences among the α_j's are all that matter, and they are unaffected by the arbitrary choice of one of them. Thus, we set α_n equal to an arbitrary constant, and calculate the α_j's for the inside goods in two steps. First, **s** is converted into a vector of π_j's:

$$\pi_n = \varepsilon/\beta\bar{p}, \qquad \varepsilon \in (0, \beta\bar{p}) \tag{6}$$

$$\pi_j = s_j(1 - \pi_n), \qquad j = 1, 2, \ldots, n - 1. \tag{7}$$

The logs of the ratios of π_j to π_n,

$$\ln(\pi_j/\pi_n) = \alpha_j - \alpha_n - \beta p_j, \tag{8}$$

are then solved for the α_j's, given α_n and **p**.

To complete the model, we assume: each product is initially sold by a single firm; each firm has constant marginal cost, c_j; and there are no fixed costs. We also assume that the equilibrium is Nash in prices both pre- and postmerger. We also assume for the present that economies of scale and scope cannot be realized through merger. Finally, we assume that product characteristics other than price are fixed, so that a merger cannot result in any strategic effects other than those involving price. In particular, mergers cannot lead to entry, or to product repositioning by established firms.

Given these assumptions, each of the first-order conditions for profit maximization [Equation (14) below] can be solved uniquely for the implied value of c_j.[7] With all the demand and cost parameters, it is straightforward to calculate the effects of a merger on prices and shares by solving the postmerger first-order conditions for profit maximization.[8] Anderson and de Palma (1992) and Anderson, de Palma, and Thisse (1992: 264–66) have proved the existence and uniqueness of the equilibrium.

In logit models, the welfare effect of a change in any argument of the utility function is calculated as the compensating variation necessary to restore consumers to the original level of utility. As Small and Rosen (1981) have shown, the change in consumer welfare brought about by changing prices from $\mathbf{p}^0$ to $\mathbf{p}^1$ is given by[9]

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7. For certain parameter values, negative marginal cost is implied by Equation (14) if a firm's share is sufficiently great. Negative marginal costs would cause mergers to have unrealistic welfare effects, so we assume throughout that all shares are small enough that all marginal costs are positive. With all product prices equal to unity, as we generally assume, avoiding negative marginal costs requires $\text{argmax}\{s_j\} < (\beta - 1)/(\beta - \varepsilon)$, and there can be a negative marginal cost only if demand is inelastic.

8. As Berry (1994) notes, this must be done numerically. We do this calculation and all calculations using Mathematica. We would be happy to provide the Mathematica code upon request.

9. Raising one or more prices reduces this measure of change in consumer welfare as long as both the terms in square brackets in Equation (9) are positive. To assure that they are, we choose a large value for α_n.

$$\left[\ln \sum_j \exp(\alpha_j - \beta p_j^1) - \ln \sum_j \exp(\alpha_j - \beta p_j^0) \right] \beta^{-1}. \tag{9}$$

Setting α_n arbitrarily does not affect this measure,[10] but it does preclude the calculation of the total consumer welfare pre- or postmerger. For comparison purposes, we express the change in consumer welfare and the change in total welfare (change in consumer welfare plus the increase in industry profits) as a percentage of premerger total revenue for inside goods.

The analysis of the nested-logit model is quite similar. With a single nest, for example, the choice set, C, is divided into two subsets. One subset, N, consists of the goods in the nest, which are especially good substitutes for each other. The other subset, O, consists of the remaining goods in C. Letting $\delta \in (0, 1)$ be the parameter that controls the strength of the nest, and defining

$$D = \sum_{k \in O} \exp(\alpha_k - \beta p_k) + \left[\sum_{k \in N} \exp((\alpha_k - \beta p_k)/\delta) \right]^\delta, \tag{10}$$

the choice probabilities are

$$\pi_j = \exp(\alpha_j - \beta p_j)/\delta \left[\sum_{k \in N} \exp((\alpha_k - \beta p_k)/\delta) \right]^{\delta-1} D^{-1}, \qquad j \in N \tag{11}$$

$$\pi_j = \exp(\alpha_j - \beta p_j) D^{-1}, \qquad\qquad\qquad\qquad j \in O. \tag{12}$$

It is simple to verify that setting $\delta = 1$ reduces this to Equation (2). Thus, the effect of the nest is weaker the closer the nest parameter is to unity. As shown by Morey (1992), the change in consumer welfare brought about by changing prices from $\mathbf{p}^0$ to $\mathbf{p}^1$ is given by

$$[\ln D(\mathbf{p}^1) - \ln D(\mathbf{p}^0)] \beta^{-1}. \tag{13}$$

3. The Effects of Mergers on Price and Welfare in Logit Oligopoly

The first-order conditions for profit maximization premerger for the simple logit simplify to

$$p_j - c_j = 1/\beta(1 - \pi_j) = \bar{p}[\beta\bar{p}(1 - s_j) + \varepsilon s_j]^{-1}. \tag{14}$$

Equation (14) implies: Larger firms have higher price–marginal cost margins; increasing β and thus the substitutability among the inside goods decreases all

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10. This is easily shown. Increasing any α_j by $\Delta\alpha_j$, while holding the choice probabilities constant, increases all the others by the same amount. By totally differentiating Equation (9), it can be verified that increasing all of the α_j by the same amount leaves the value of Equation (9) unchanged.

margins; and increasing ε, and thus substitutability between the inside goods and the outside goods, also decreases all margins.

It is straightforward to show that the derivatives of the merged firm's profit function with respect to the prices of its two products, evaluated at premerger shares and prices, are both positive. Since Anderson, de Palma, and Thisse (1992: 270–72) have shown that the profit function is quasi-concave, it follows that the merged firm increases both prices as a result of the merger.

The first-order conditions for profit maximization postmerger simplify to

$$p_1 - c_1 = p_2 - c_2 = 1/\beta(1 - \pi_m) = \bar{p}[\beta\bar{p}(1 - s_m) + \varepsilon s_m]^{-1}, \qquad (15)$$

with the subscript m used to denote the merged firm. Since the price–marginal cost margin is the same for both products, it follows that the merged firm increases the price of the product with the smaller share by a greater *absolute* than it increases price for the product with the larger share.[11] The intuition behind this result is straightforward. The effect of the merger on the price of the smaller-share product is the greater one because the merger causes a larger portion of its loss in sales from a price increase to be recaptured by the other product involved in the merger [as indicated by the cross elasticities of demand in Equation (4)] and because the premerger markup is smaller for the smaller-share product [as indicated by the first-order condition in Equation (14)].

Analyzing first-order conditions does not suffice to demonstrate how different the price increases are for the two products. That is illustrated in Table 1, which gives the percentage price increases for the products of the merged firm for various mergers for which the combined share of the merging firms is 40 percent.

At premerger shares and prices, the slope of the best-response function for the price of product k with respect to a change in the price of product j is

$$\pi_j \pi_k/(1 - \pi_k) = s_j s_k(\beta\bar{p} - \varepsilon)^2/\beta\bar{p}[\beta\bar{p}(1 - s_k) + \varepsilon s_k]. \qquad (16)$$

This slope is clearly positive and greater for larger-share products. This slope is always less than one, and if the two merging firms (firm j's) have equal shares, this slope is less than one-half. For nonmerging firms smaller than both merging firms, this slope is less than one-sixth. Consequently, all of the nonmerging firms increase price as a result of a merger, but larger firms increase price more than smaller ones, and nonmerging firms increase price less than, often much less than, the merged firm increases the weighted average of its two prices. Further, greater concentration among the nonmerging firms causes a merger to result in a greater increase in the industry average price.

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11. If the product with the smaller premerger share has the higher price, its price may increase *proportionately* less than that of the product with the larger premerger share.

Table 1. Price Increases for the Products of the Merged Firm Resulting from Mergers with a Combined Share for the Merging Firms of 40 Percent

Shares of the Merging Firms	Percentage Price Increase for the Smaller-Share Product	Percentage Price Increase for the Larger-Share Product	Share-Weighted Average Percentage Price Increase
1, 39	9.09	0.18	0.33
5, 35	7.88	0.93	1.57
10, 30	6.47	1.90	2.86
15, 25	5.19	2.92	3.71
20, 20	4.01	4.01	4.01

Note: For all mergers it is assumed that all premerger prices equal unity. $\beta = 5$, $\varepsilon = 1$, and there are two nonmerging firms with equal shares.

Even though all prices rise, the share-weighted industry average price may fall if higher priced products experience proportionately greater output reductions. Such would be the case if the merging firms had higher than average premerger prices. On the other hand, because all prices increase, it follows from Equation (9) that consumer welfare decreases as a result of a merger. Each firm's profits also increase as a result of a merger.

A merger leads to a reallocation of output from the merging firms to the nonmerging firms, because the nonmerging firms raise price less than the merged firm raises the weighted average of its two prices. If the nonmerging firms, on average, were larger than the merging firms, their costs would be lower or perceived quality higher, and this shift in relative outputs would enhance welfare. A merger would cause a net increase in welfare if the output reallocation were relatively large because of relatively high cross elasticities of demand (specifically $\beta\bar{p}$), and if there were relatively little substitution to the outside good because of a relatively low aggregate elasticity of demand.[12]

If the shares of the merged firm's products differ premerger, there is a shift in output from the product with the smaller premerger share to the product with the larger premerger share because the merged firm raises the price of the former product more than the price of the latter. Thus, the average cost of the merged firm is less than that of the merging firms or the perceived quality higher. A merger would cause a net increase in welfare if the output reallocation were relatively large because of relatively high cross elasticities of demand and a substantial inequality of the merging firms' shares, and if there were relatively little substitution to the outside good because of a relatively low industry elasticity of demand. Indeed, it is possible for mergers to en-

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12. As an example, the merger of two firms with shares of 10 percent enhances welfare if $\beta\bar{p} = 7$, $\varepsilon = 1$, and there is one nonmerging firm.

hance welfare even though they involve firms with a combined share in excess of 50 percent.[13]

While either of the foregoing effects may cause a merger to produce a net increase in welfare, that is far more likely with the former effect. In particular, the former effect causes mergers to produce a net increase in welfare over a significantly larger range of the demand parameters. Both of the effects arise in Cournot models as well.[14] In the Cournot context, the only possible source of an efficiency gain from a merger is the exploitation of cost differences among firms. That is not the case with differentiated products because there are perceived quality differences, which also affect welfare.

In the logit context, larger firms generally are inferred to have both lower marginal costs and higher α_j's than their smaller counterparts, but that is not the case if larger firms have significantly higher prices. It is easy to see from Equation (14) that, with sufficiently high prices, larger firms would have higher costs despite higher markups. It might seem that the welfare effects of mergers must depend a great deal on premerger prices and inferred marginal costs and α_j's. That is not the case, however, because the effects of a merger on our measures of change in consumer welfare and change in total welfare are independent of premerger relative prices.[15] Holding s, β, ε, and $\bar{p}$ constant, while changing individual prices, forces offsetting changes in the c_j's and the α_j's that maintain the premerger price–marginal cost margins and differences among the $(\alpha_j - \beta p_j)$'s. With the α_j's changing in this way, the postmerger first-order conditions are satisfied by the same markups and shares for any set of relative premerger prices, and premerger prices do not affect the welfare change calculations.

The effects of merger efficiencies in the form of cost reductions are easily incorporated into the analysis of a merger. If a merger would be expected to reduce one merging firm's marginal cost, then the simulations of the post-merger equilibrium can incorporate that assumption. One possibility we consider below is that the merged firm's marginal cost is equal to the lesser of the marginal costs of the two merging firms. Estimates of fixed cost savings are even more easily incorporated into the welfare calculations. Finally, it is possible in some instances to incorporate effects of mergers on perceived product quality, for example, if the estimated logit demand system has a linear function of product characteristics instead of just α_j constants. Any predict-

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13. As an example, the merger of firms with shares of 45 and 10 percent enhances welfare if $\beta\bar{p} = 15$, $\varepsilon = .5$, and there is one nonmerging firm.

14. See Farrell and Shapiro (1990) and Werden (1991). The literature on Cournot models has not focused on shift of production from the merging firms to nonmerging firms as we do. The importance of these effects may be greater in a differentiated products model than in a homogeneous product Cournot model, because firm asymmetries may be greater. Cournot mergers also tend not to be privately profitable, but that is not the case for Bertrand mergers (see Deneckere and Davidson, 1985).

15. This statement no longer holds if mergers are assumed to reduce the marginal cost of the higher-cost merging firms to a level dependent on the marginal cost of the lower-cost merging firm.

able effects of a merger on product characteristics could then easily be taken into account.

4. Comparative Statics Involving the Demand Elasticity Parameters

To facilitate the discussion in this section and the next, it is useful to introduce some additional notation to refer to the price and welfare effects resulting from a merger:

$\Delta p_j \equiv$ the percentage price increase for firm j

$\Delta p_{\text{Ind}} \equiv$ the share-weighted average percentage price increase for the industry

$\Delta CW \equiv$ change in consumer welfare as a percentage of premerger revenue

$\Delta W \equiv$ change in total welfare as a percentage of premerger revenue.

The comparative static effect of changing the demand elasticity parameters is of interest for the conventional reasons and also because it indicates the importance of uncertainty about the values of these parameters. If the estimates are very sensitive to small changes in parameter values, precise estimates of parameter values are important, and if the reverse is true, rough estimates or guesses are satisfactory. Unfortunately, it is not possible to derive analytically general comparative static results relating to the magnitudes of the effects of changing parameter values.[16] Nevertheless, it appears from numerous simulations that the effect of changing the demand elasticity parameters is very much the same on Δp_m, Δp_{Ind}, and ΔCW, and is quite consistent from one merger to the next.

For various parameter values, Table 2 gives the effect on Δp_{Ind} of the merger of two firms with shares of 20 percent, assuming two nonmerging firms with equal shares. The figures in the table are relative to those for a base case of $\beta \bar{p} = 5$ and $\varepsilon = 1$.[17] The relative effects of the merger on ΔCW are almost exactly the same, and the effects on Δp_m are approximately the same. Moreover, for a large number of other mergers we have examined, the relative effects are approximately the same as those presented in Table 2.

There are three notable features of Table 2. First, the effects of mergers are more sensitive to changes in ε than to changes in $\beta \bar{p}$. Second, if either $\beta \bar{p}$ or ε is high, the effect of changing the other is rather modest. Thus, if either of the parameters is known to be high, uncertainty about the other is of limited importance. Third, Δp_m, Δp_{Ind}, and ΔCW are not monotonic in $\beta \bar{p}$; all three peak between $\beta \bar{p} = 4.3$ and $\beta \bar{p} = 4.6$. The reason for this is straightforward. If $\beta \bar{p}$ is very large, the inside goods are such good substitutes for each other that a merger matters little, and if $\beta \bar{p}$ is very small, the inside goods are such poor substitutes for each other that a merger matters very little. Consequently, the effect of a merger must be greatest at some intermediate value of $\beta \bar{p}$.

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16. It can be shown analytically that multiplying both β and ε by the same positive constant has the effect of multiplying the price and welfare effects of mergers by the reciprocal of that constant.

17. These parameter values are not arbitrarily chosen. The empirically based value of $\beta \bar{p}$ used in the next section is roughly 4.8, and unitary demand elasticity is in the range of many empirical estimates.

Table 2. Relative Effects of Mergers on Δp_{Ind} with Various Values of β and ε

β \ ε	0.5	1	2	4
2.5	2.00	1.31	0.38	—
5.0	1.24	1.00	0.65	0.19
7.5	0.89	0.76	0.58	0.32
10.0	0.70	0.62	0.50	0.33

ΔW is not considered in Table 2 because the effect of changing parameter values is quite different on ΔW than on Δp_m, Δp_{Ind}, and ΔCW, and because the effect of changing parameter values is not consistent from one merger to the next. Within the range of parameter values considered, ΔW is not monotonic in either $\beta \bar{p}$ or ε. For the merger considered in Table 2, if $\beta \bar{p} = 5$, the maximum welfare loss occurs at $\varepsilon \approx 1.97$. If $\varepsilon = 1.97$, the maximum welfare loss occurs at $\beta \bar{p} \approx 3.22$. If both parameters are allowed to vary (and all marginal costs must be positive), the maximum welfare loss occurs at $\beta \bar{p} \approx 1.25$, $\varepsilon \approx 0.43$. ΔW is not monotonic in ε because the profit increase from mergers rises much more rapidly as ε is decreased than ΔCW decreases.

5. Calculated Price and Welfare Effects of Mergers among U.S. Long-Distance Carriers

To illustrate both the process of simulating mergers with a logit model and the sort of predictions that flow from the logit model, we consider hypothetical mergers among existing U.S. long-distance carriers. There are three major long-distance carriers in the United States—AT&T, MCI, and Sprint—all serving throughout the nation. In 1991, they accounted for 87 percent of the long distance revenues. The remaining 13 percent of revenue was divided among roughly 500 minor carriers, most of which operate in only a small fraction of the U.S., and no one of which accounted for as much as 1 percent of industry revenues. For the purposes of estimating the effects of hypothetical mergers, we assume that choice set faced by any particular subscriber consists of the three major carriers and three of the many minor carriers, assumed to have equal shares.

For market shares, we use actual 1991 nationwide shares of minutes of usage.[18] For prices, we use actual July 1991 average revenue per minute.[19] We take ε to be 0.7, which is in the range of widely cited, published estimates

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18. The raw data are from Federal Communications Commission, *Statistics of Communications Common Carriers*, 1991/1992 ed., which reports revenues. The revenue shares are: AT&T, 62.2 percent; MCI, 15.0 percent; Sprint, 9.7 percent; all others, 13.1 percent. We convert these into minutes shares using the average price data. The minutes shares we use are: AT&T, 61.4 percent; MCI, 15.5 percent; Sprint, 9.8 percent; each of the three minor carriers, 4.4 percent.

19. The price data were supplied by Michael Ward and are for five south central states. The average revenues in cents per minute are: AT&T, 16.6; MCI, 15.9; Sprint, 16.2. We have no price data for the minor carriers and assume that their average price was the same as Sprint's.

Table 3. Calculated Price and Welfare Effects of Possible Mergers Assuming that Mergers Do Not Affect Marginal Costs

Merger	$\Delta p_{AT\&T}$	Δp_{MCI}	Δp_{Sprint}	Δp_{Minor}	Δp_{Ind}	ΔCW	ΔW
AT&T–MCI	4.87	25.70	0.49	0.21	5.06	−5.63	−2.296
AT&T–Sprint	2.90	0.48	24.42	0.12	2.82	−3.40	−1.243
AT&T–Minor	1.22	0.20	0.12	23.82, 0.05	1.18	−1.45	−0.488
MCI–Sprint	0.58	2.10	3.35	0.03	1.01	−0.98	−0.046
MCI–Minor	0.25	0.89	0.03	3.28, 0.02	0.44	−0.43	−0.011
Sprint–Minor	0.16	0.04	0.85	1.96, 0.01	0.27	−0.27	−0.0003
Minor–Minor	0.07	0.02	0.01	0.84, 0.00	0.12	−0.12	0.003

Note: For mergers involving a minor firm, the Δp_{Minor} column lists first the price increase for the merging minor firm(s), then that for the nonmerging minor firm(s).

of the elasticity of demand for long-distance service (see Taylor, 1980: 170; and Taylor, 1993). We use an estimate of β derived from a proprietary study of intra-LATA (Local Access Transport Area) carrier choice based on a survey of choices in hypothetical situations, so β could be estimated without instrumental variables. What matters for the welfare effects of mergers is $\beta\bar{p}$, and a β of 29 with the prices we use gives roughly the same value of $\beta\bar{p}$ as in the proprietary study.[20]

Table 3 presents the calculated price and welfare effects for all possible mergers among the carriers, assuming that costs are unaffected by mergers. A striking feature of these results is the substantial asymmetry of the price increases between the two merging firms and between the merging and non-merging firms. For the mergers involving firms of very different size—those involving AT&T and those between MCI or Sprint and a minor firm—the smaller merging firm increases price at least several times as much as the larger merging firm. For all of the mergers, the nonmerging firms increase price by a fraction of the amount that the larger merging firm increases price.

The merger of two minor firms actually enhances total welfare slightly, and the remaining mergers not involving AT&T lessen welfare very little; even the MCI–Sprint merger reduces welfare by less than 0.05 percent of premerger revenues. Mergers not involving AT&T have such small effects on welfare because AT&T's very large share implies that it has a combination of cost and perceived quality advantages over its rivals,[21] so the substitution to AT&T induced by mergers of its rivals has a welfare-enhancing effect. Mergers involving AT&T are far less likely to be welfare enhancing. As noted above, shifts in production between two merging firms are less likely to cause mergers to enhance welfare than are shifts in production from the merging firms to the nonmerging firms.

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20. Additional parameter values within the confidence interval of $\beta\bar{p}$ are considered in Froeb, Werden, and Tardiff (1993).

21. As explained above, it does not matter for the welfare calculations whether the advantage is in cost or perceived quality.

Table 4. Calculated Price and Welfare Effects of Possible Mergers with Non-AT&T Carriers in a Nest, Assuming that Mergers Do Not Affect Marginal Costs

Merger	$\Delta p_{AT\&T}$	Δp_{MCI}	Δp_{Sprint}	Δp_{Minor}	Δp_{Ind}	ΔCW	ΔW
AT&T–MCI	3.71	17.34	0.84	0.36	3.89	−4.22	−1.546
AT&T–Sprint	2.20	0.85	16.69	0.21	2.19	−2.59	−0.762
AT&T–Minor	0.92	0.35	0.20	16.48, 0.09	0.91	−1.10	−0.274
MCI–Sprint	0.77	2.84	4.49	0.13	1.33	−1.30	0.012
MCI–Minor	0.32	1.14	0.12	4.19, 0.05	0.56	−0.55	0.024
Sprint–Minor	0.20	0.13	1.03	2.39, 0.03	0.34	−0.34	0.030
Minor–Minor	0.09	0.06	0.03	0.98, 0.01	0.15	−0.15	0.018

Note. For mergers involving a minor firm, the Δp_{Minor} column lists first the price increase for the merging minor firm(s), then that for the nonmerging minor firms(s).

It has been suggested that consumers perceive non-AT&T carriers as especially close substitutes for each other. Thus, the proper specification of demand may be a nested-logit model, with the non-AT&T carriers in a nest. We do not know what value of the nest parameter would be appropriate, and arbitrarily choose 0.7 so we can illustrate the effects of adding a nest. As Table 4 shows, all mergers not involving AT&T enhance welfare. Adding the nest makes the non-AT&T firms closer substitutes and thus introduces greater competition. This causes mergers not involving AT&T to have greater price effects. Introducing a nest also affects the inferred marginal costs and α's, and these effects cause the mergers not involving AT&T to be welfare enhancing. With lower nest parameter values, the welfare gain from these mergers is even greater.

Finally, we consider the possibility that the cost advantages of large firms can be extended through merger. Table 5 presents the calculated price and welfare effects of the mergers under that assumption, using the simple logit model. All the mergers except AT&T–MCI enhance welfare although the

Table 5. Calculated Price and Welfare Effects of Possible Mergers Assuming the Cost Advantages of Large Firms Can be Extended Through Merger

Merger	$\Delta p_{AT\&T}$	Δp_{MCI}	Δp_{Sprint}	Δp_{Minor}	Δp_{Ind}	ΔCW	ΔW
AT&T–MCI	5.95	10.96	0.44	0.19	4.92	−5.06	−0.587
AT&T–Sprint	3.77	0.41	6.33	0.10	2.75	−2.91	0.130
AT&T–Minor	1.64	0.16	0.10	4.14, 0.04	1.15	−1.21	0.162
MCI–Sprint	0.33	2.35	0.14	0.02	0.59	−0.56	0.306
MCI–Minor	0.10	1.04	0.01	−1.14, 0.01	0.18	−0.20	0.195
Sprint–Minor	0.12	0.03	0.89	0.89, 0.01	0.20	−0.20	0.047
Minor–Minor	0.07	0.02	0.01	0.84, 0.004	0.12	−0.13	0.003

Note For mergers involving a minor firm, the Δp_{Minor} column lists first the price increase for the merging minor firm(s), then that for the nonmerging minor firms(s).

welfare gains are all small. The welfare effects of the mergers are much more favorable in this case not only because of the direct effect of the cost savings from the mergers of different-sized firms. Also important is the indirect effect the cost reduction has on the price increases resulting from the mergers. The smaller-share merging firm generally raises price a great deal under the assumption that marginal costs are unaffected by merger. Under the assumption that the marginal cost of the smaller-share merging firm is reduced to that of the larger-share merging firm, the reduction in the marginal cost of the smaller-share merging firm causes its price to be increased far less. If MCI were to merge with a minor firm, the marginal cost reduction for the product of the minor firm would be sufficiently great that the merged firm would reduce the price for the minor firm's product.

6. Limitations of the Logit Model and Alternative Models

The logit model is based on the restrictive assumption known as Independence of Irrelevant Alternatives (IIA) (see Ben-Akiva and Lerman, 1985: 108–11). This assumption implies that when the price of one product is increased, consumers switch to others in proportion to the relative shares of those products. Actual preferences, however, may yield very different substitution patterns because certain goods may be viewed as closer substitutes than others. For example, in response to a price increase for BMWs, the IIA assumption implies that much of the substitution will be to top-selling models like Ford Taurus and Honda Accord and very little to models sold by Acura, Cadillac, Lincoln, and Mercedes Benz, which have much smaller shares. We suspect that the IIA assumption does not hold in this situation.

The logit model is easily generalized by the incorporation of nests, as we did above. In the car example, there could be a nest for luxury cars and a nest within that nest for foreign or German luxury cars. This certainly makes the logit model more general, but it is still restrictive in two senses. The IIA assumption still applies within a nest and between nests. In addition, a single nest parameter controls how close the goods in a nest are as substitutes for each other and how close they all are as substitutes for goods outside the nest. This means, for example, that making goods in a nest better substitutes for each other requires making them worse substitutes for all other goods. Finally, Brownstone and Small (1989) find that a common estimation technique used for the nested logit is both unstable and inefficient, and yields biased standard errors.

Whether the logit model—simple or nested—fits a particular data set can be examined through an explicit test of the IIA assumption. The leading test was derived by Hausman and McFadden (1984). Its application and the application of alternative tests are discussed by Ben-Akiva and Lerman (1985: 183–94). The IIA assumption has been rejected as a null hypothesis by some empirical studies, but it has been accepted by others (for example, Ben-Akiva and Lerman). When the IIA assumption is not rejected by the data, the logit model can be considered to be a reasonable approximation.

We believe that it is always useful and appropriate to supplement the

traditional, structural analysis of mergers in differentiated products industries with simulations. As we discuss presently, logit is not the only possible model and another model may be preferable. We would not hesitate, however, to use the logit model whenever a lack of time or money effectively foreclosed other options. Unlike other modeling approaches, the logit model with our parameterization requires very little information—just readily observable prices and shares, and two demand elasticity parameters, which can be guessed at in a pinch. Even when the logit model is not strictly applicable and the specific predictions of logit simulations cannot be considered reliable, logit simulations provide much needed perspective. They indicate asymmetries in, and order of magnitude of, the price effects of mergers, and they provide a basis for trading off possible cost savings against price increases.

One alternative to using the logit model is to assume that all of the relevant elasticities are invariant to the price and quantity changes resulting from a merger. With this strong assumption, the effects of a merger are easily calculated from postmerger first-order conditions and elasticities. One notable example of this approach is Baker and Bresnahan (1985). They calculate the price effects of several beer mergers using estimated residual demand elasticities. Their approach assumes that elasticities are constant and that the merged firm acts as a Stackelberg leader. Although this approach has the advantage of requiring the estimation of very few elasticity parameters, it still requires some individual-firm cost shifters as instruments. This may be a significant drawback since good instruments are hard to find and weak instruments yield estimates with very large standard errors (see Froeb and Werden, 1991: 44–46).

Most significantly, the assumption of price-invariant elasticities is not tested, and it is unlikely to hold. Most often, increasing the price for a product increases the elasticity of its demand. There is a strong tendency for this to occur, because the price increase induces a quantity decrease, and both of these effects tend to increase the demand elasticity. If the elasticity of demand does increase as price is increased, assuming the contrary leads to an overestimate of the price increases from mergers. Froeb and Werden (1992) explore this phenomenon, and illustrate its significance. As a further illustration, consider the merger of AT&T with MCI, assuming logit demand. The percentage price increases calculated using the Baker-Bresnahan approach are 48.6 for AT&T and 101.8 for MCI.[22] These estimates exceed the actual figures in Table 3 by a factor of 10 in the case of AT&T and a factor of 4 in the case of MCI.[23] Virtually all of the error arises from the assumption of constant elasticity of demand; the assumption of Stackelberg equilibrium turns out to be unimportant.

Hausman, Leonard, and Zona (1994) also calculate the price effects of sev-

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22. The calculations involve dividing both sides of Equation (14) by p_j, evaluating the right-hand side at premerger prices, then solving for p_j.

23. The margins of error are smaller for the other mergers and quite small when the price increases predicted by the logit simulations are very small.

eral beer mergers. They assume a multilevel, almost ideal demand system (AIDS), and estimate a host of elasticities, using a panel of scanner data from supermarkets for various cities. To identify the parameters of the demand system, they assume that costs are the same across cities and that demand is independent across cities. This allows them to use prices in one city as an instrument for price in each other city, thus avoiding problems associated with using cost shifters as instruments, and making it possible to use high-frequency scanner data, which may be superior to alternatives. However, the assumption of demand independence across cities is likely to be violated for products, including beer, that have significant seasonal effects or have special promotions at the same time in many cities. In addition, they assume that elasticities are constant in estimating the effects of a merger.

A very different approach has been taken by Berry (1994) and Berry, Levinsohn, and Pakes (1993). They also use panel data, but their data are for various models of products like automobiles, and consumers are assumed to base their choices on observable product characteristics (or on unobservable attributes correlated with observable characteristics). Rather than assuming that elasticities are invariant to changes in prices and quantities, this approach exploits the fact that they do vary. A given product's equilibrium price is affected by variation in the characteristics of competing products, provided that the first product's equilibrium demand elasticity changes. Thus, the model is identified by using characteristics of competing products as instruments.

This approach assumes that characteristics of competing products are independent of demand shocks. This assumption is difficult to test, and it is likely to be violated if firms compete on the basis of model characteristics. This approach is similar to ours in that it uses first-order equilibrium conditions to estimate marginal costs. This line of research was only recently begun and has not yet been applied to mergers, but such an application would be a logical step.

Another solution to the identification problem, and the one used to generate the estimate of the cross elasticity parameter used in the simulations of long-distance carrier mergers, is to use hypothetical choice data rather than actual choice data. Hypothetical choice data are generated by asking consumers what choices they would make at specified prices. Specifying exogenous price variation obviates the need for any instruments. It also eliminates the need to extrapolate outside the range of observations, which is typically required with data on actual choices and can lead to significant error in estimation (see Froeb and Werden, 1991: 39; Froeb and Werden, 1992: 243–46). Furthermore, a consumer survey can be designed so that the right-hand-side variables are orthogonal. When that is the case, White (1980) has shown that a specific functional form, such as the logit, can be motivated as a first-order approximation to the unknown true function.

7. The Structural Standards of the Merger Guidelines

The 1992 Merger Guidelines state the specific enforcement standards used by the two federal antitrust enforcement agencies—the U.S. Department of Jus-

tice and the Federal Trade Commission. The general enforcement standards are based on two concentration measures[24]—the *increase in the HHI,* defined as twice the product of the shares of the merging firms, and the *postmerger HHI,* defined as the Herfindahl-Hirschman Index (HHI) for the relevant market plus the increase in the HHI. Mergers fall in a safe harbor if the postmerger HHI for the relevant market is at most 1,000 or the increase in the HHI is at most 50. If the postmerger HHI exceeds 1,800, the 1992 Guidelines (§ 1.51) "presume that mergers producing an increase in the HHI of more than 100 points are likely to create or enhance market power," but they provide that this presumption may be overcome by any of a number of other factors they discuss in later sections, including one on product differentiation.

Section 2.21 of the 1992 Guidelines articulates a special enforcement standard for mergers in differentiated products industries. Under that standard, a merger is presumed to harm consumers significantly if the combined share of the merging firms is at least 35 percent. By negative implication, one may infer that a merger will be presumed not to harm consumers significantly if the combined share of the merging firms is below 35 percent. Typically, a combined share for the merging firms of 35 percent translates into a change in the HHI of 400–500 points, which is far in excess of the 100–point threshold of the general standard.[25]

The foregoing analysis suggests several observations about these standards.[26] First, a standard based on the combined share of the merging firms is problematic because the price and welfare effects of mergers vary greatly for a given combined market share. This is illustrated in Table 1, in which all the mergers have the same combined share for the merging firms. A far better measure for use as a structural standard would have been the product of the shares of the merging firms or, equivalently, the change in the HHI.

The overall level of concentration, holding the shares of the merging firms constant, is a relevant factor since the nonmerging firms increase price more the greater the concentration among them. On the other hand, this effect is rather small, and greater concentration among the merging firms gives rise to a welfare gain from the reallocation or production. The net effect of an increase in concentration among the nonmerging firms, holding the shares of

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24. These concentration measures are not meant to be predictions about the actual shares and concentration that will prevail postmerger (see Werden, 1991: 1002–3).

25. The section on mergers in differentiated products industries was just added in the 1992 edition of the Guidelines. At the same time, a 35 percent test was added (in § 2.22) for mergers in homogeneous goods industries, when the effect of concern does not involve coordination (i.e., when the effect is that in a Cournot model). There is no similar test when the effect of concern does involve coordination (i.e., when it stems from explicit collusion or some sort of repeated game equilibrium). Thus, the 1992 Guidelines must reflect a conscious decision to reduce the range of mergers subject to challenge on the basis of effects termed "unilateral," that is, effects not arising from coordination. This is curious because noncooperative models such as Cournot and Bertrand offer a far firmer basis for merger policy than does any notion of collusion (see Hay and Werden, 1993).

26. There is a much more extensive discussion on this subject in Werden and Froeb (1993).

the merging firms constant, is likely to be to mitigate the adverse welfare effects of a merger, and it can even reverse them.

Most importantly, if the logit model, which motivates the Guidelines' discussion of mergers in differentiated products industries, is appropriate, then it is far better to simulate the effects of a merger using that model than to rely on simple structural indicators. Simulations are more accurate generally; they identify asymmetric price effects; they identify possible welfare gains from production reallocation; and they provide a means of trading-off possible merger efficiencies. The last point is particularly significant because trading off price effects and possible efficiencies is a hopeless task if price effects are simply proxied for by market shares.

8. Conclusions

Economists have long been critical of the practice in antitrust law of predicting the competitive effects of mergers on the basis of shares of a delineated relevant market.[27] Early critics of this practice were advocates of monopolistic competition theories, and the argument that market shares are inadequate predictors is strongest in differentiated products industries. As Edward Chamberlin (1950: 86–87) put it:

> "Industry" or "commodity" boundaries are a snare and a delusion—in the highest degree arbitrarily drawn, and, wherever drawn, establishing at once wholly false implications both as to competition of substitutes within their limits, which supposedly stops at their borders, and as to the possibility of ruling on the presence or absence of oligopolistic forces by the simple device of counting the number of producers included.[28]

These criticisms are well taken, and they can be addressed by replacing the traditional structural approach with simulations of the effects of mergers within the context of a specified oligopoly model. We consider the logit model, but other models can also be used. Our version of the logit model is specifically designed to capture one of the important factors to which Chamberlin refers—competition from products outside the designated group. More generally, simulations capture the other factor to which Chamberlin refers—the oligopolistic interaction within the designated group. Taking cost differences and consumer preferences into account, simulations predict the complex, asymmetric price effects of mergers in differentiated products industries. Simulations also indicate effects on welfare of production reallocation induced by mergers, and they make it straightforward to incorporate reductions in fixed or marginal costs in an explicit welfare analysis.

Simulating the effects of mergers unfortunately requires undertaking some-

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27. This practice in merger cases can be traced to the Supreme Court's 1948 *Columbia Steel* decision. Economists began expressing opposition to the practice in 1934 (see Werden, 1992: 125–29).

28. Much the same argument was made recently by Fisher (1987: 27), and Hausman, Leonard, and Zona (1992) make a related argument based on the Lerner index.

thing like market delineation, because it is necessary to impose some structure, such as delineating a set of inside goods. The simulations are affected by the delineation of this set because the inside substitutabilities are different from those between the inside and outside goods. On the other hand, narrowing the set of inside goods increases the aggregate elasticity of demand for the inside goods (and possibly the estimated cross elasticity parameter as well), so the simulations may not be very sensitive to the market delineation.

The logit model used here is a reasonable approximation to the structure of demand in some differentiated products industries. Our version of the logit model is also very practical. The two demand elasticity parameters can be easily estimated, or guessed at in a pinch, and premerger prices and market shares are the only other information required for simulations. Thus, we offer a simple, low-cost way in which to get some idea of the effects of mergers in differentiated products industries. The logit model can always be used to obtain a "quick and dirty" estimate, and it is possible to test whether the model is a good approximation to the actual demand system.

There are many situations in which the logit model is not appropriate. A nested logit model may be used in such cases, as may a probit model. In either case, estimation and simulation are more difficult, but still possible. Berry (1994) and Berry, Levinsohn, and Pakes (1993) employ far more complicated models, and such models may also be used to simulate the effects of mergers. These models may prove preferable to the logit model, but their advantages and disadvantages remain to be explored.

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